FuturICT

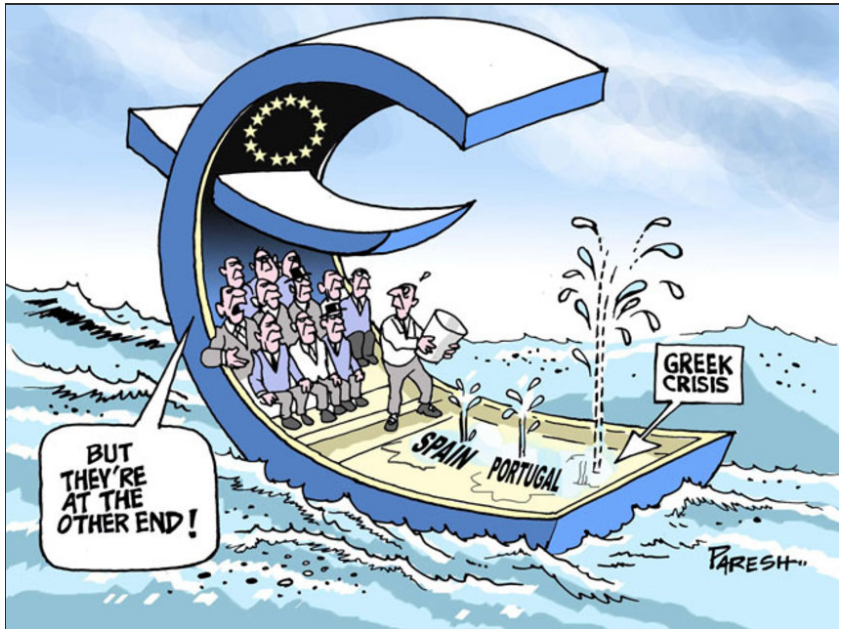
Dirk Helbing (ETH Zurich)
and > 700 supporters

www.futurict.eu

We Face Intensified and New, Global Problems

Problems:

1. World financial and economic crises
2. Global terrorism and international wars
3. Political instabilities, revolutions
4. Global environmental change, extreme weather
5. Organized crime, cybercrime
6. Quick spreading of emerging diseases
7. Global disruptions of supply chains
8. Migration and integration problems



3 mega-events in 2010, which may even change the global distribution of power:

1. Financial Crisis
2. Arab Spring
3. Japanese Earthquake and Nuclear Disaster

Old Problems: External Threats to Society

But the Challenges Humanity is Facing in the 21st Century are Novel

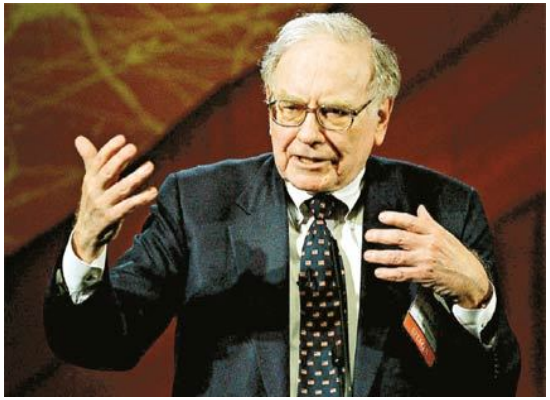
Lee C. Bollinger, president of Columbia University, formulated the issue as follows: "The forces affecting societies around the world ... are powerful and novel. The spread of global market systems ... are ... reshaping our world ..., raising profound questions. These questions call for the kinds of analyses and understandings that academic institutions are uniquely capable of providing. Too many policy failures are fundamentally failures of knowledge."

New Problems: Self-Destabilization of Society

«Europa ist eine tickende Zeitbombe»

Tages Anzeiger **October 12, 2011**

Derivatives as Financial Weapons of Mass Destruction



Buffett warns on investment 'time bomb'

Derivatives are financial weapons of mass destruction

Warren Buffett

The rapidly growing trade in derivatives poses a "mega-catastrophic risk" for the economy ..., legendary investor Warren Buffett has warned.

The world's second-richest man made the comments in his famous and plain-spoken "annual letter to shareholders", excerpts of which have been published by Fortune magazine.

The derivatives market has exploded in recent years, with investment banks selling billions of dollars worth of these investments to clients as a way to off-load or manage market risk.

But Mr Buffett argues that such highly complex financial instruments are time bombs and "financial weapons of mass destruction" that could harm not only their buyers and sellers, but the whole economic system. (BBC, 4 March, 2003)

As Coupling Gets Stronger, System Behavior Can Change Completely: Traffic Breakdowns

Thanks to Yuki Sugiyama

As Coupling Gets Stronger, System Behavior Can Change Completely: Crowd Disasters

Many Global Challenges Result from Cascading Effects

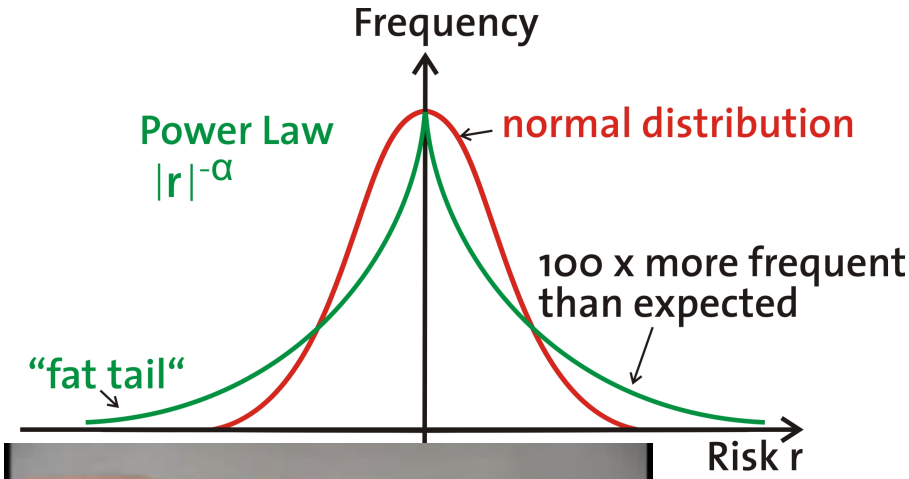
- We have now a global exchange of people, money, goods, information, ideas…
- Globalization and technological change have created a strongly coupled and interdependent world

Network infrastructures create pathways for disaster spreading!

Our World Has Become Strongly Coupled and Complex

1. Faster dynamics
2. Increased frequency of extreme events – can have any size
3. Self-organization and strong correlations dominate system dynamics
4. Unwanted feedback, cascade and side effects, counterintuitive behavior
5. Predictability goes down
6. System optimization not possible in real time, even with supercomputers
7. Possibilities of external control are limited
8. Larger vulnerability to random failures and external shocks
9. Old recipes do not work anymore
10. Loss of trust

Our world shows all these features!



The problem is the wrong perspective (component-, not interaction-oriented). We need a science of complex systems!

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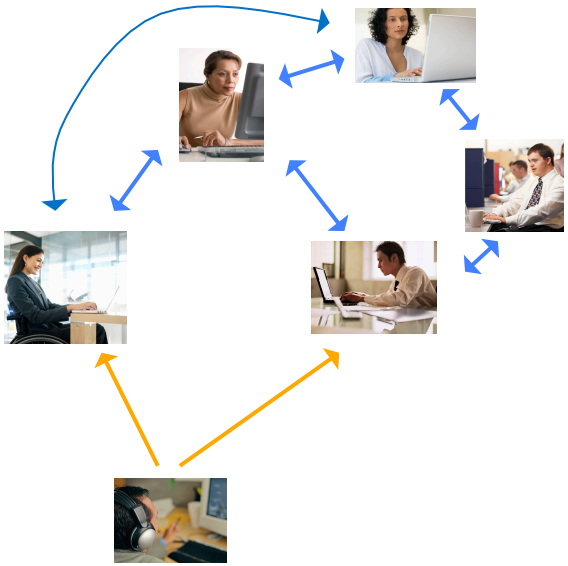
Future ICT Systems Are Artificial Social Systems

- ICT systems are made up of billions of non-linearly interacting components (computers, smartphones, software agents, …).
- More and more of them take autonomous decisions, based on an internal representation ("subjective" interpretation) of the surrounding world and expectations regarding future conditions.
- This effectively makes them artificial social systems.
- Example: Computer-based automatic trading strategies now perform the majority of transactions in our world's financial system.
- Most ICT systems are not designed and tested for the collective behavior of their components.
- A lack of coordination, instabilities, an inefficient use of resources, conflicts of interest, cybercrime and cyberwar are the result.
- Note that networking can destabilize systems!
- An understanding of social systems is needed!



Too Much Networking Can Cause Self-Destabilization: Breakdown of Cooperation

Imitation of best neighbor

- All defectors
- Small probability for strategy mutation

Different recipes, new solutions, and a paradigm shift in our understanding of the world are needed.

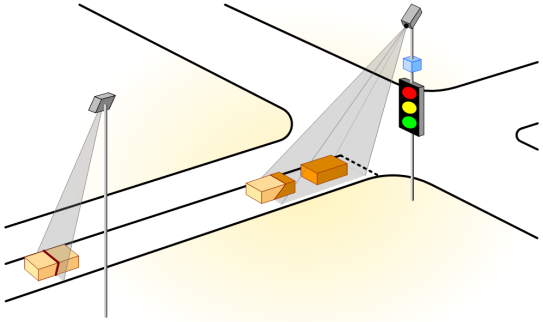
Is the Fight Against Complexity a Lost Battle?

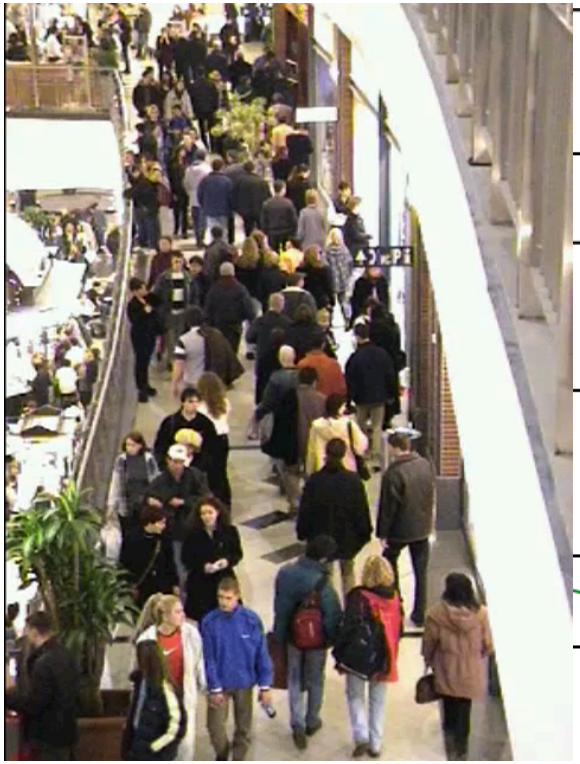
- In a strongly varying world, strict stability and control is not possible anymore or excessively expensive
- Example: Public spending deficits
- Hierarchically organized structures have a critical size, beyond which they become unstable

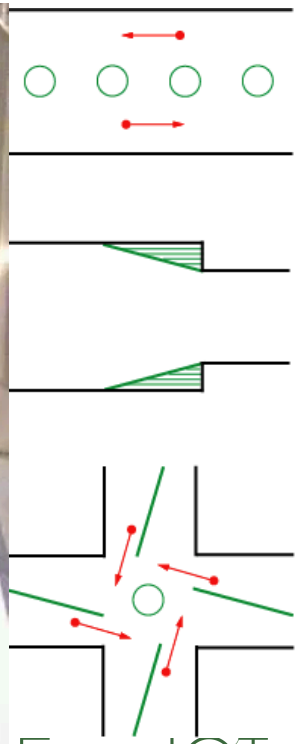
- Examples: Decay of Soviet Union; many failed mergers in the last decade (Daimler-Chrysler, BMW-Rover, Allianz-Dresdner Bank, …)
- A paradigm shift towards flexible, agile, adaptive systems is needed, possible - and overdue!

Properties of Complex Systems Can Be Utilized!

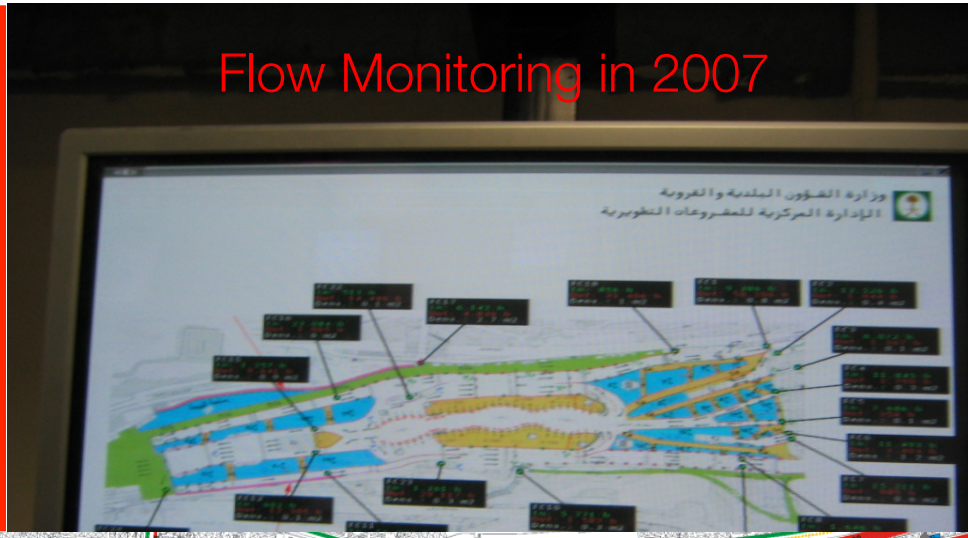
- Use the natural tendency of complex systems to self-organize (yields robust and resource-efficient solutions)
- Example: Social cooperation and norms, network of trust
- Use emergent properties of complex systems (i.e. system properties that are not predicted/implied by its system components)
- Examples: Innovation; collective intelligence, wisdom of crowds, prediction markets
- Use adaptability and flexibility/agility
- Example: Self-control of traffic lights



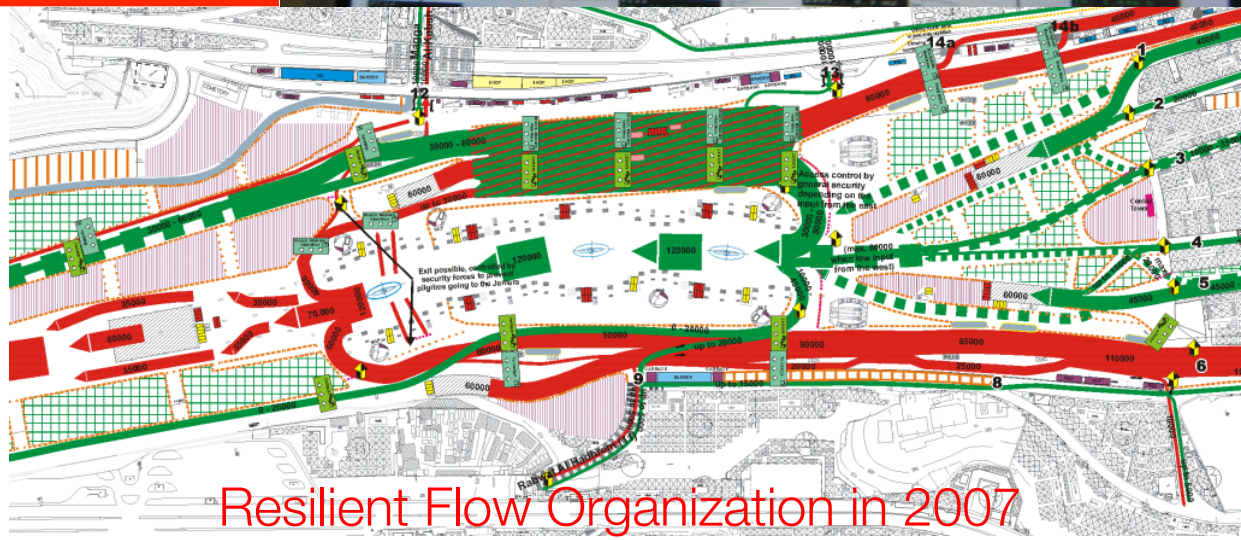




Avoiding Crowd Disasters

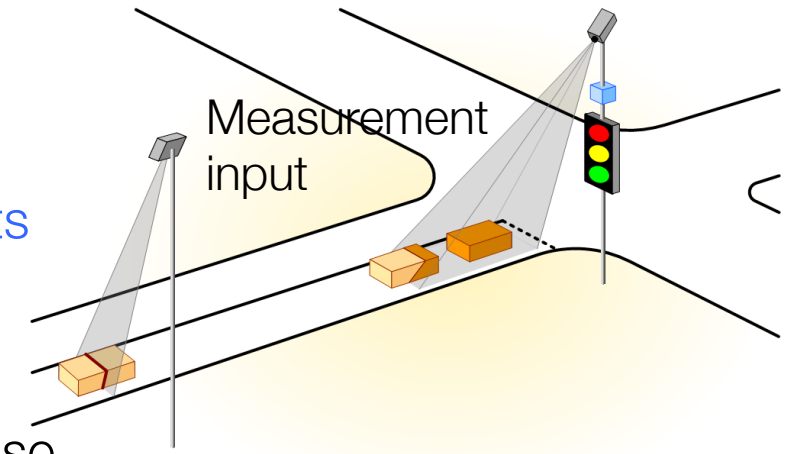


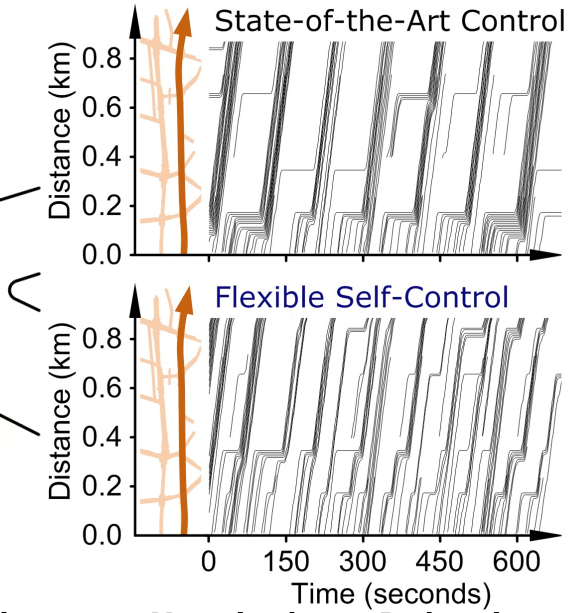
- Avoiding crossing and counter-flows
- Real-time flow monitoring
- Adaptive rerouting
- Contingency plans



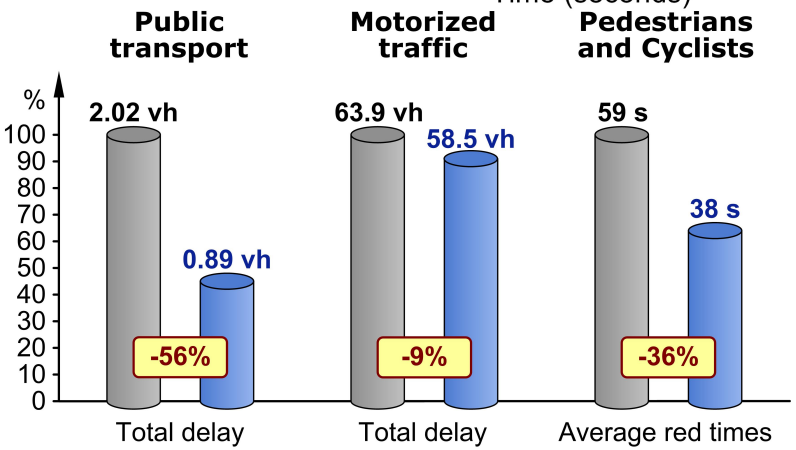
Self-Controlling Traffic

- Decentralized, bottom-up self-organization
- Responds to real-time measurements and short-term forecasts of traffic
- Optimal compromise between flexible local adaptation and coordination with neighbouring traffic lights
- Better use of scarce resources (space and time)



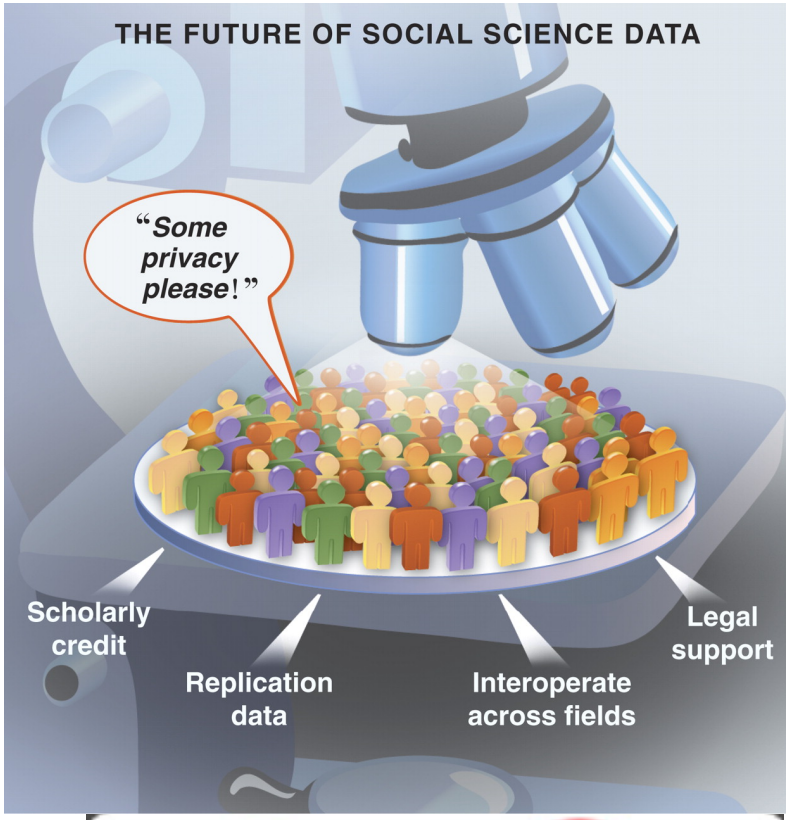


Beneficial for all modes of transport and for the environment!



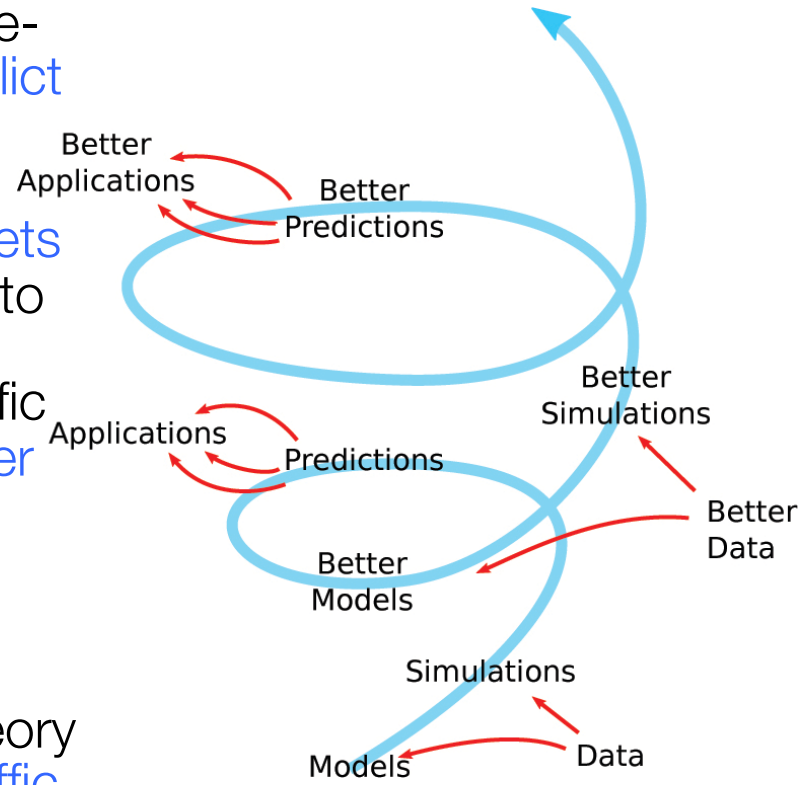
A New Era of the Social Sciences

- Experiments, Big Data and computer simulations generate many new insights
- Models considering spatial and network interactions, heterogeneity, randomness (which can change the systemic outcome dramatically!)
- Models of the emergence of social cooperation under unexpected conditions (social dilemma situations promoting tragedies of the commons)
- Models for the formation of social norms, although individuals have to make a sacrifice
- Models for the spreading of conflict and violence
- Models of collective behavior (opinion formation, crowd disasters, revolutions)
- Models considering emotions
- Models explaining conditions for other-regarding behavior
- Models with learning and communication
- Models considering cognitive complexity

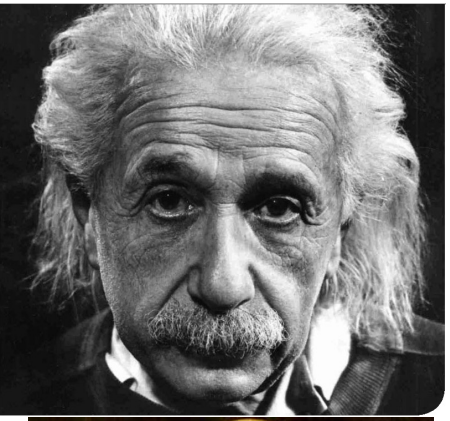


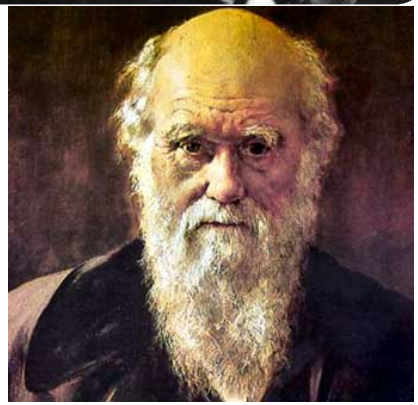
Relevance of Scientific Progress and Use Cases

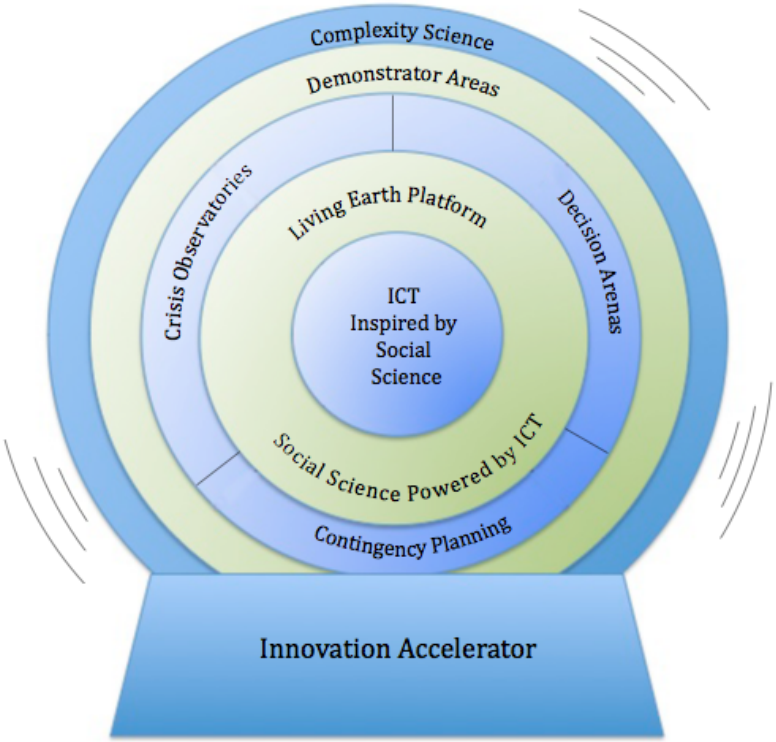
1. Models of social self-organization and segregation, strategies to reduce crime and conflict
2. Models of social cooperation, recipes to overcome tragedies of the commons
3. Opinion formation models, prediction markets
4. Models of pedestrian dynamics, measures to anticipate and avoid crowd disasters
5. Understanding of mobility patterns and traffic breakdowns, congestion avoidance, smarter cities
6. Models of financial systems to increase the robustness of stock markets
7. Simulation of supply networks, more stable and efficient production, business cycle theory
8. Models to reduce war, insurgency, drug traffic
9. Network theory and conditions for resilience, Google's page rank algorithm, reputation, trust and recommender systems, semantic web
10. Real-time measurement and simulation of pandemics, scenario-based policy recommendations, immunization strategies
11. Evolution of social groups and communities, social networking applications
12. Evolution of language, communicating robots etc.

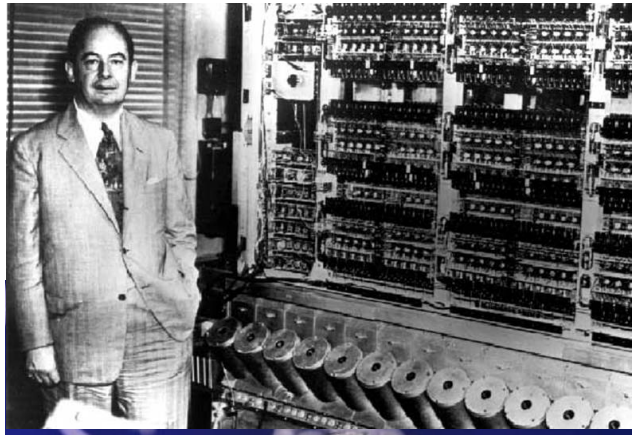


Scaling It Up: The FuturICT Knowledge Accelerator









We need to create a techno-socio-economic knowledge accelerator - a large-scale multi-disciplinary 'Apollo program' that uses current and future ICT developments to address the challenges of humanity, involving natural scientists and engineers

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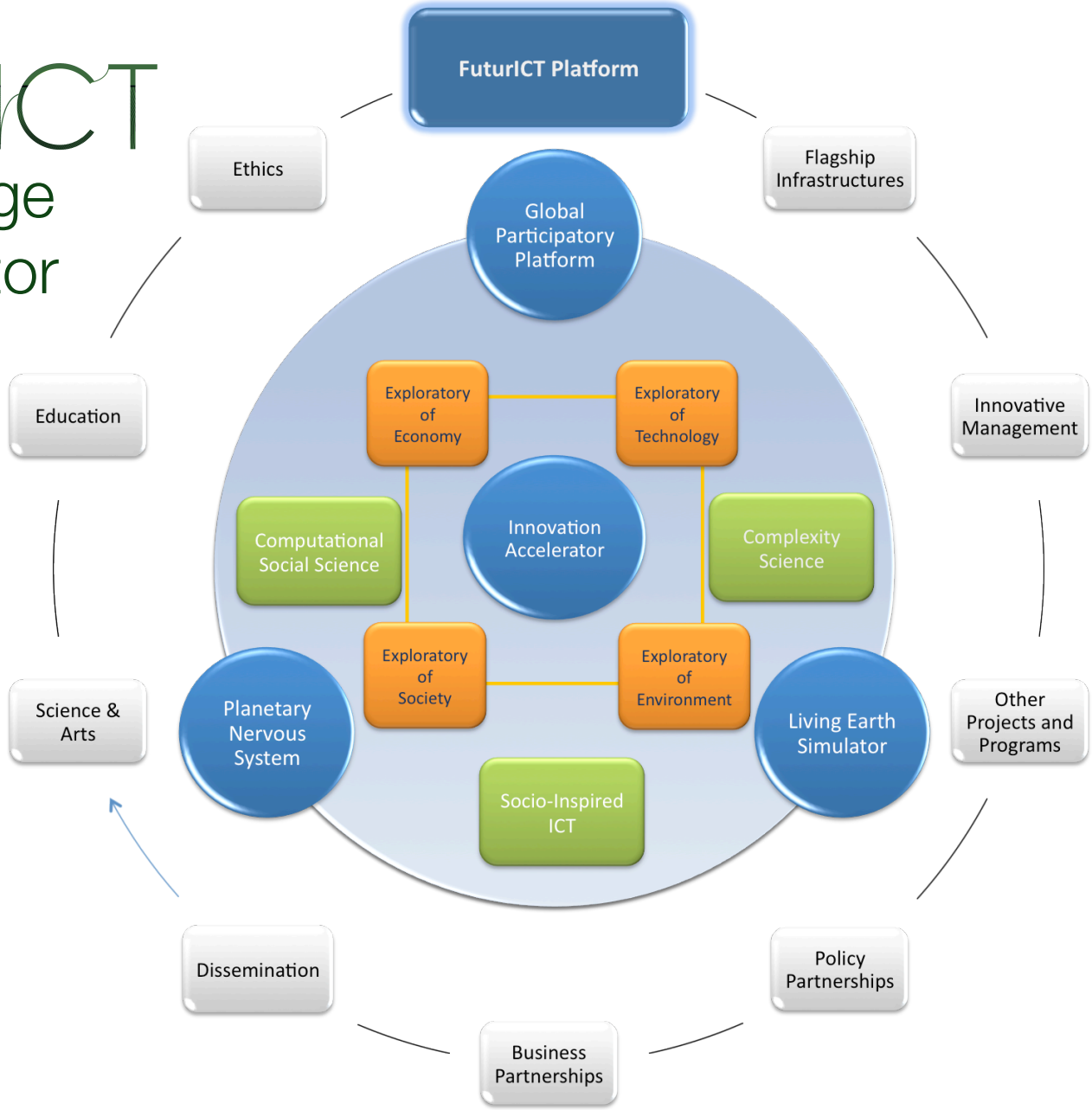
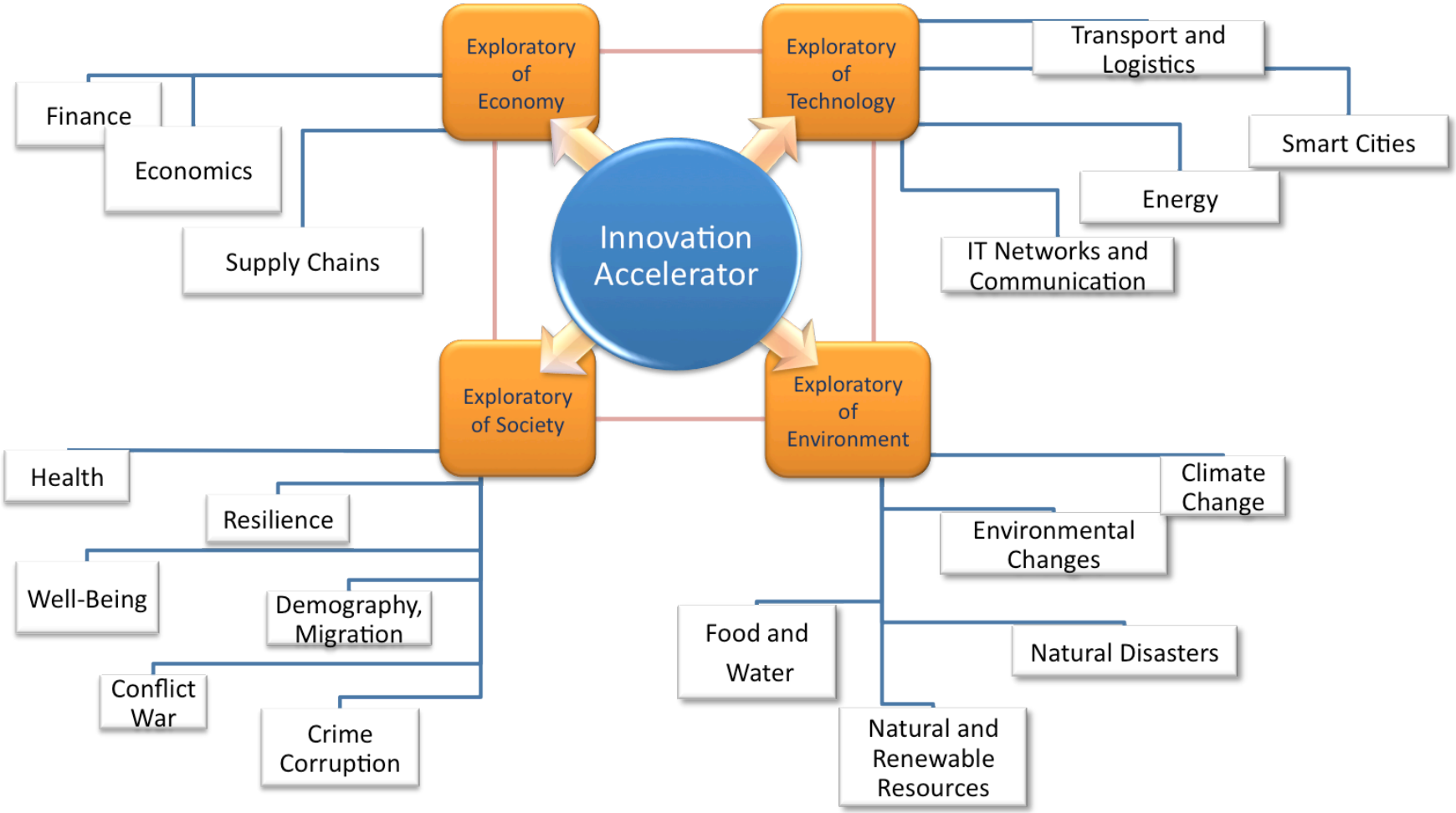
FuturICT Knowledge Accelerator



FuturICT Observatories and Exploratories



Observatory for Financial Instabilities

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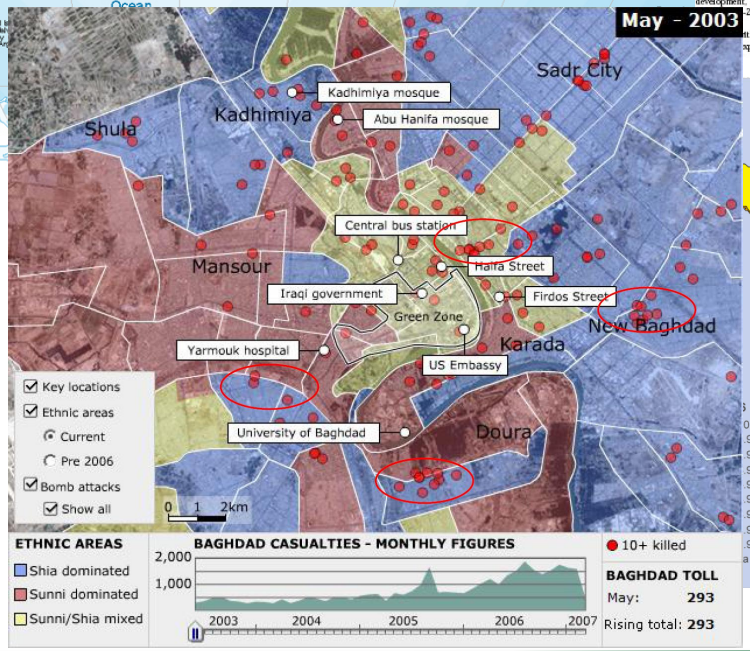
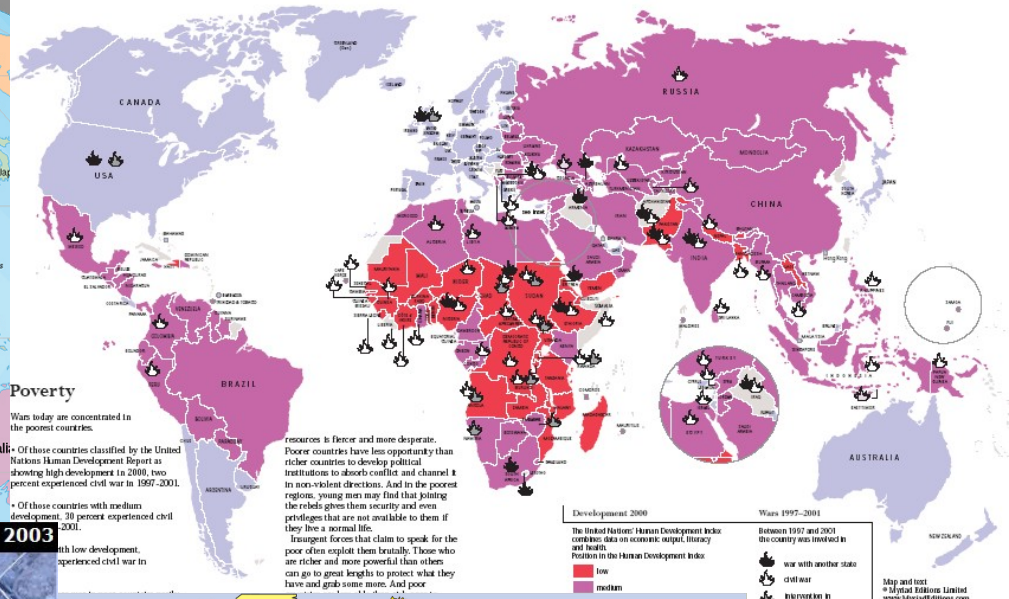
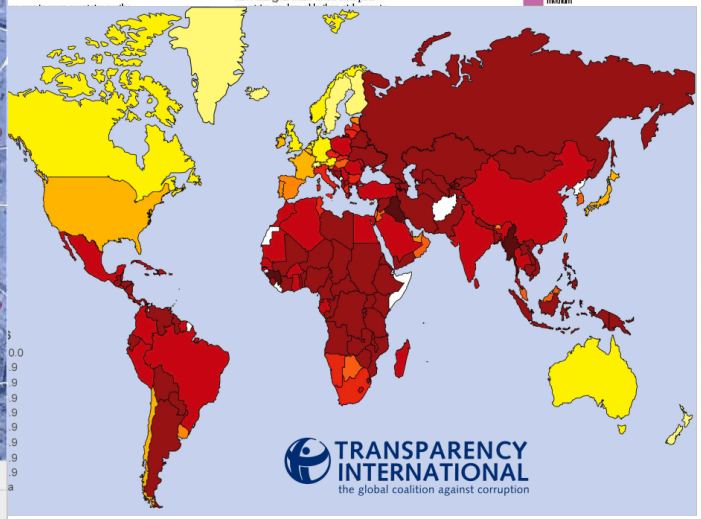
Observatory for Wars and Conflicts







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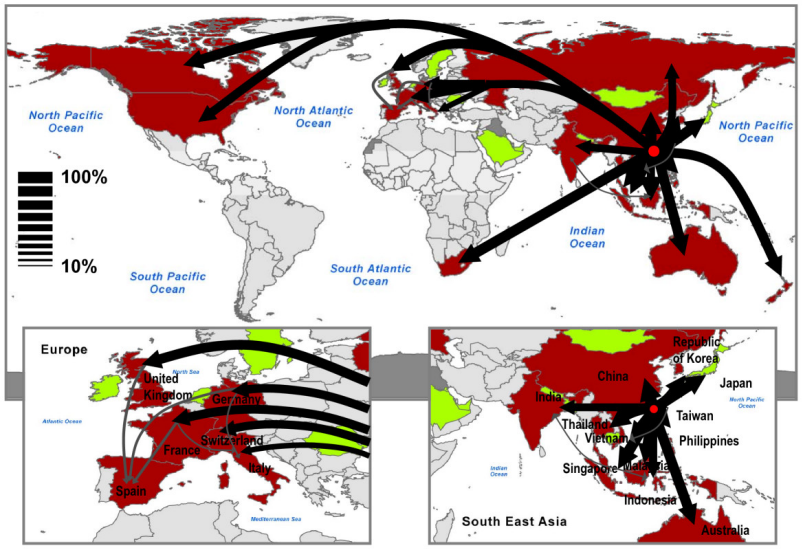
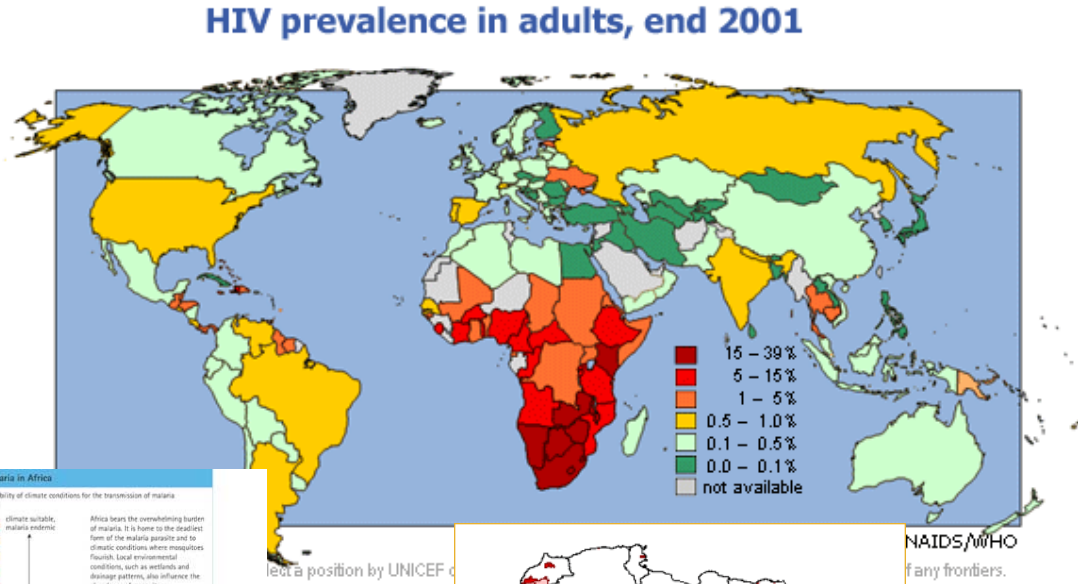
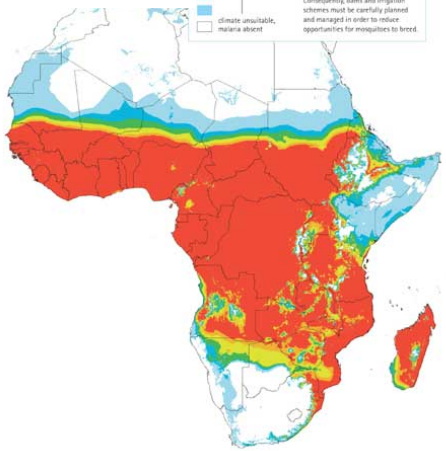
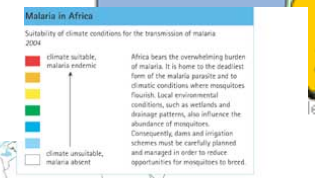
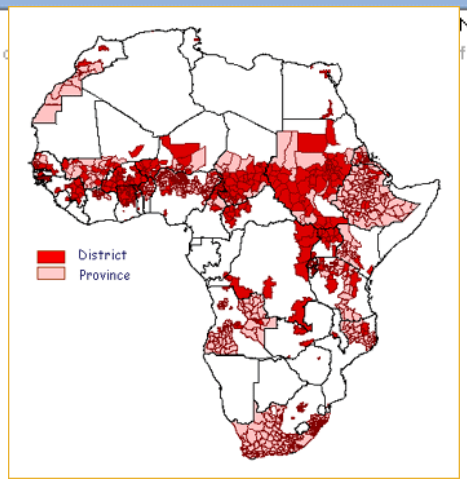
Observatory for Epidemic Spreading and Health Risks











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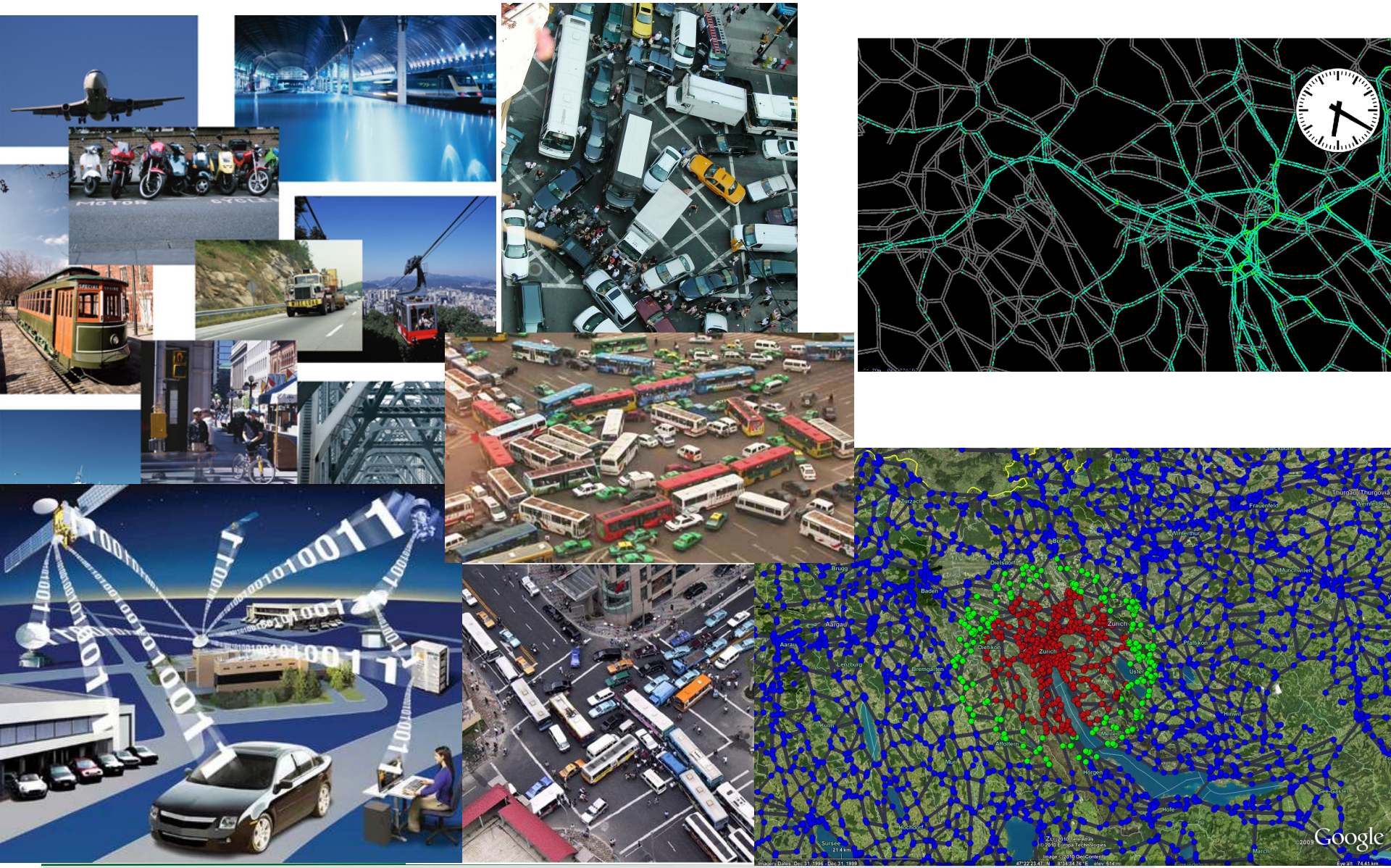
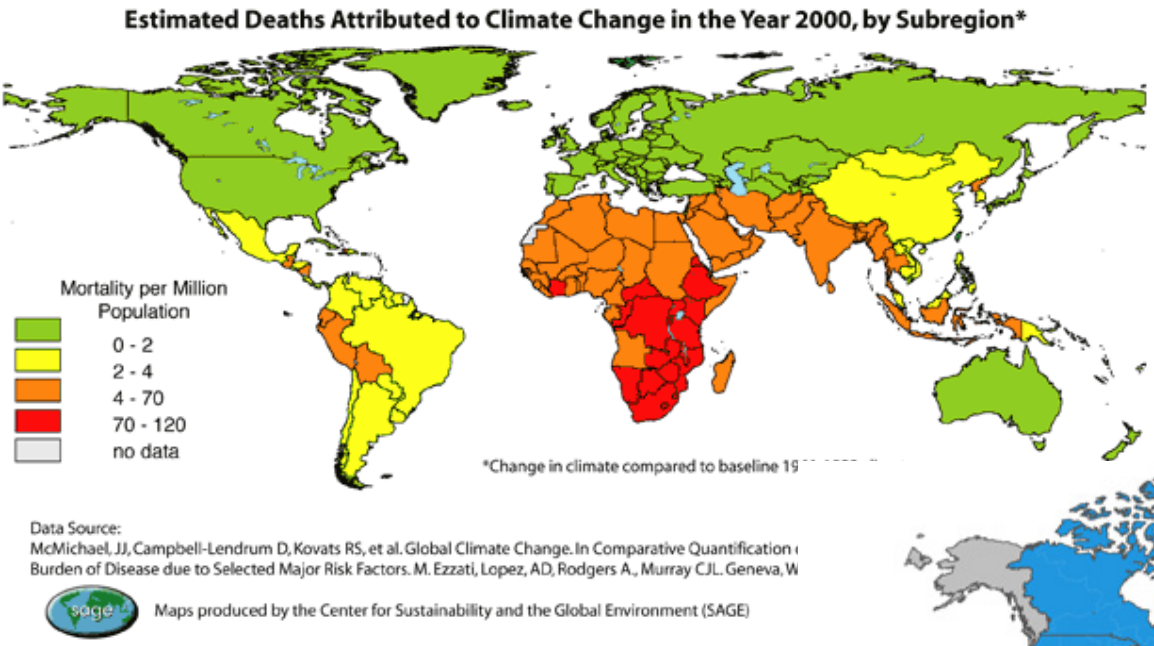
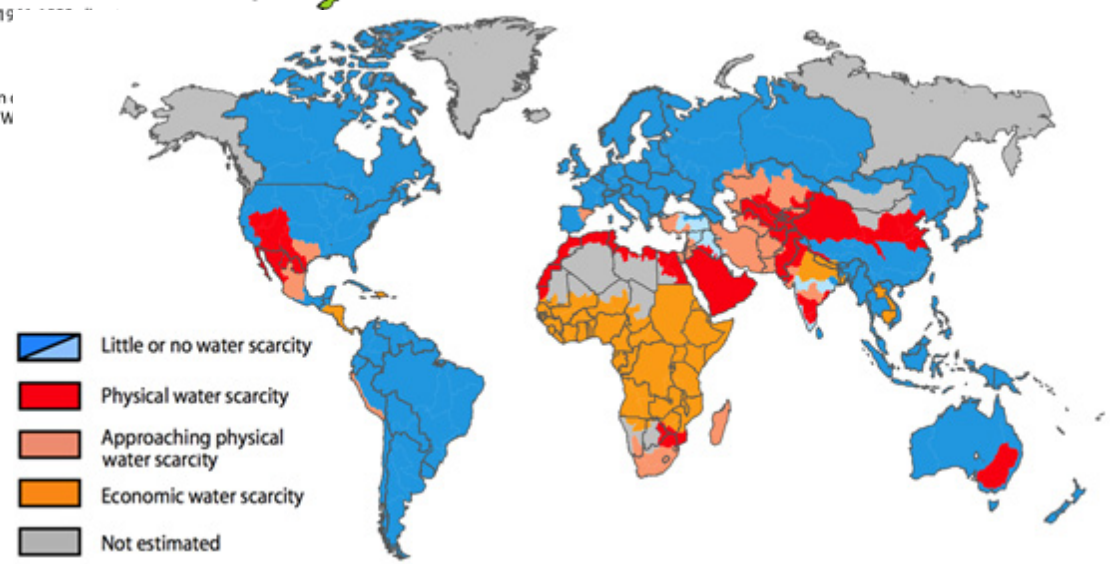
Transport and Logistics Observatory



Observatory for Environmental Change





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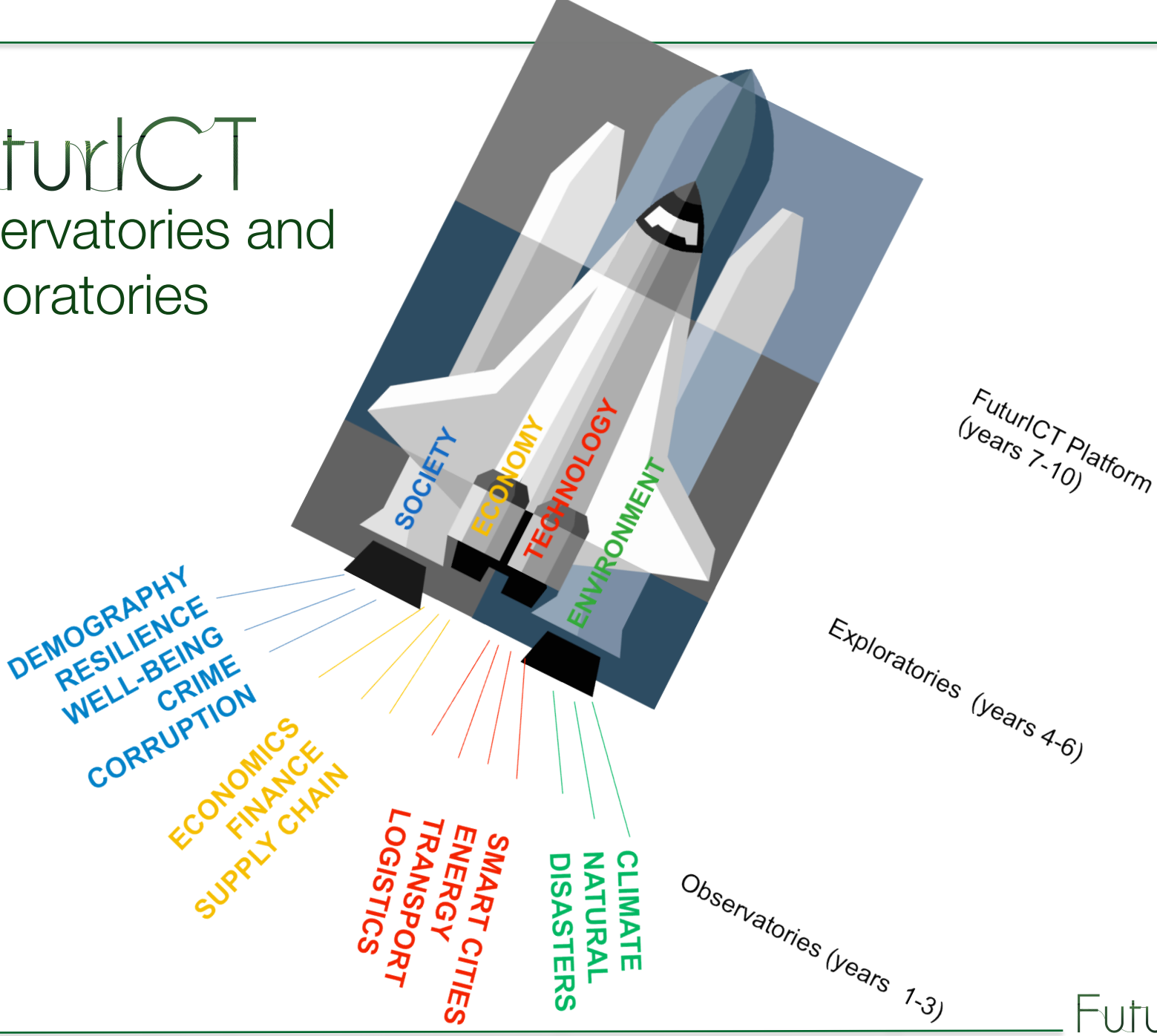
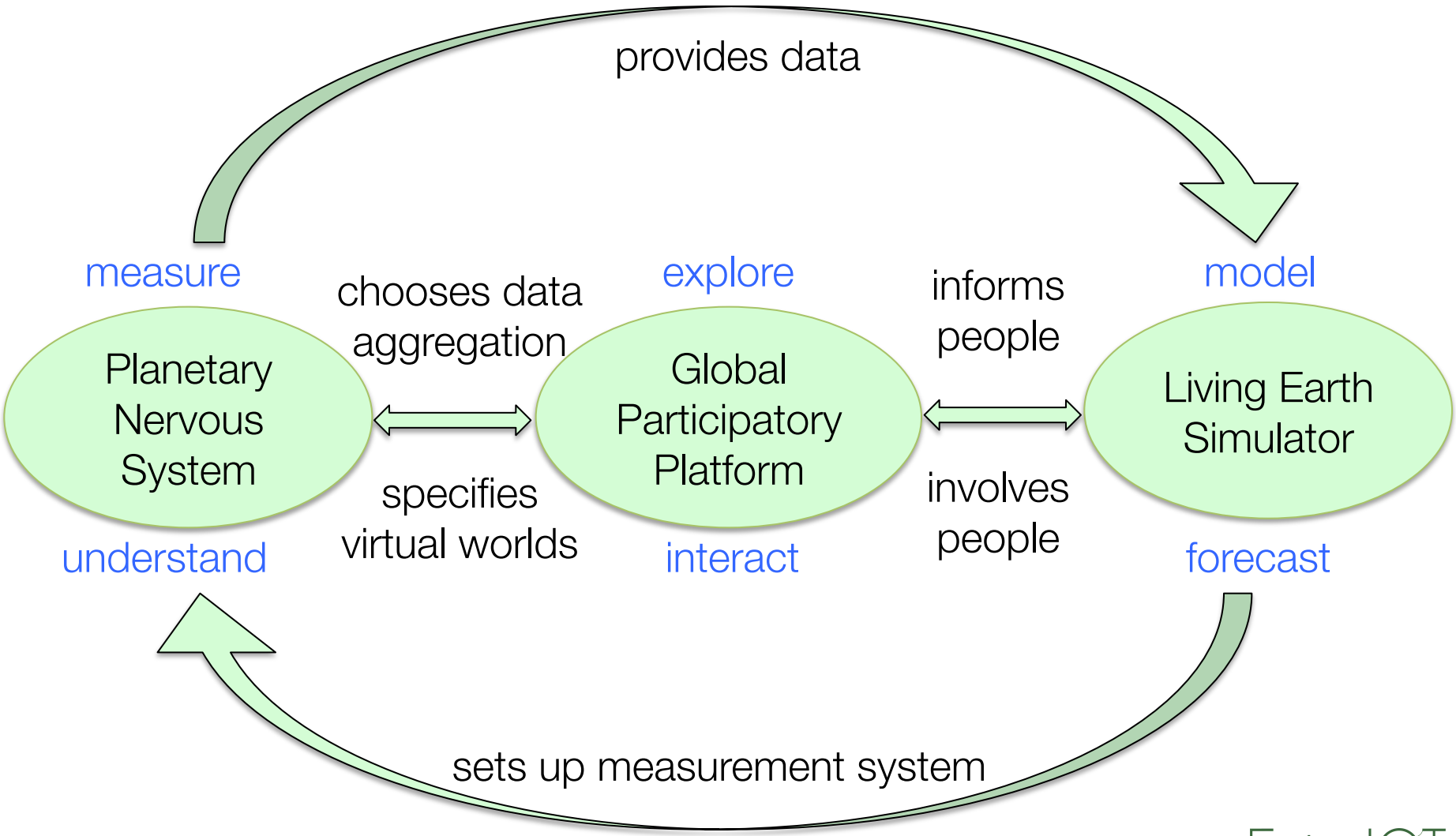
Observatories and Exploratories



New ICT to Explore and Manage Our Complex, Strongly Connected World



Reality Mining with the Planetary Nervous System

How to Establish A Planetary Nervous System

1. Goal: Measure the state of the world in real time
2. Do real-time data mining ("reality mining")
3. Use smartphones to establish a global sensor network (collaboration with Sandy Pentland of the MIT Media Lab)
4. Provide incentives to voluntarily provide data (share benefits and profits generated with the provided data)
5. Establish a reward system (people can collect points) and a micropayment system
6. Provide users control over their own data and the use of their data
7. Develop a privacy-respecting data mining approach
8. Anonymize and aggregate data "on the fly"
9. Examples: Open streetmap, earthquake sensing and warning

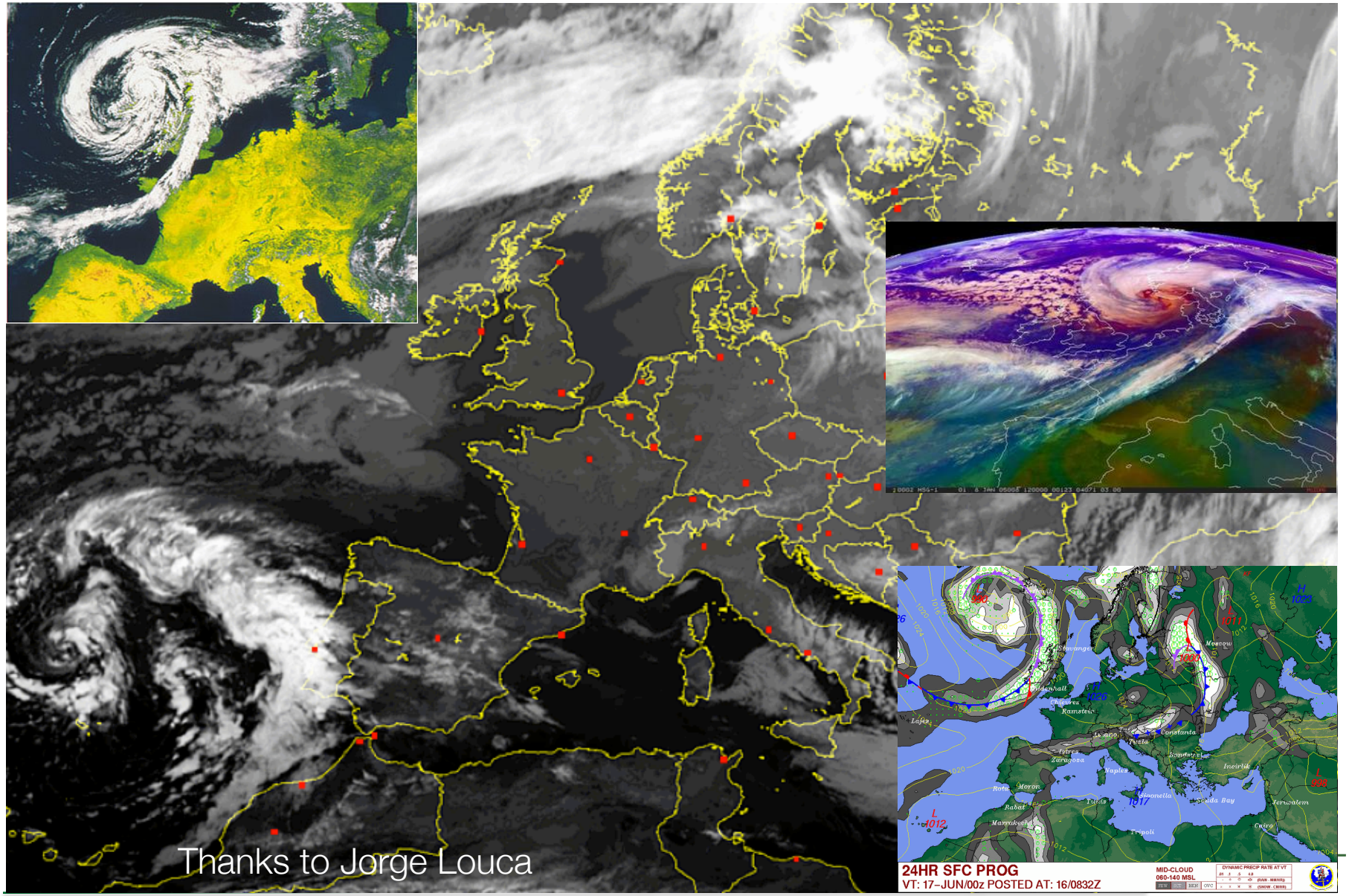
Towards Collective (Self-)Awareness

- Goal: Promote sustainability, protect the fabric of our society
- Idea: Create collective (self-)awareness
- How? Measure the "social footprint", i.e. the impact of human decisions and actions on our society
- Aggregate incoming information
- Detect possible threats and opportunities
- Anticipate possible courses of events and likely consequences of decisions through "mental simulation"
- Help resolve conflicts between incompatible demands, motives, requirements, functions, and goals
- Help avoid harmful actions

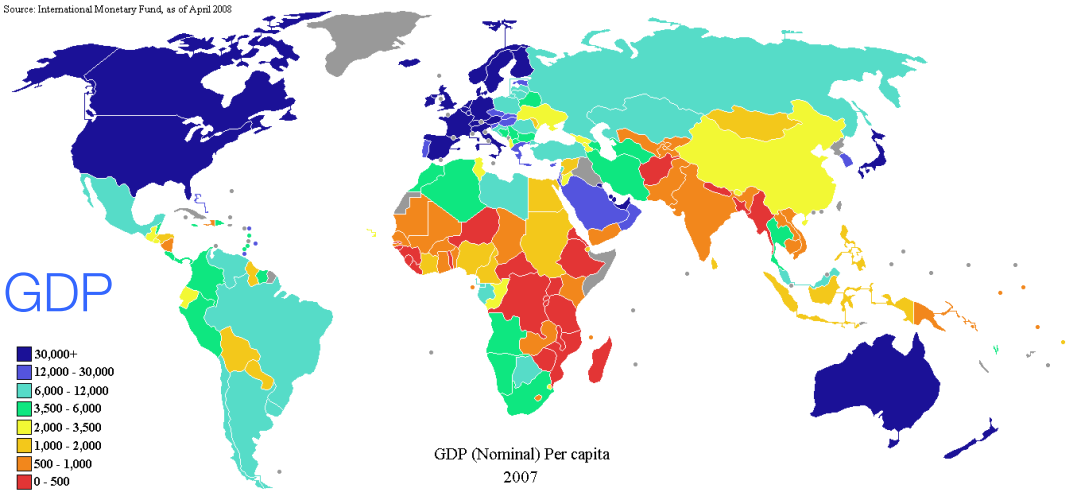
Painting by Maurits Cornelis Escher

Thanks to Andrzej Nowak

Measuring the Socio-Economic Climate



Observatory for Social Well-Being, e.g. Measuring Social Capital

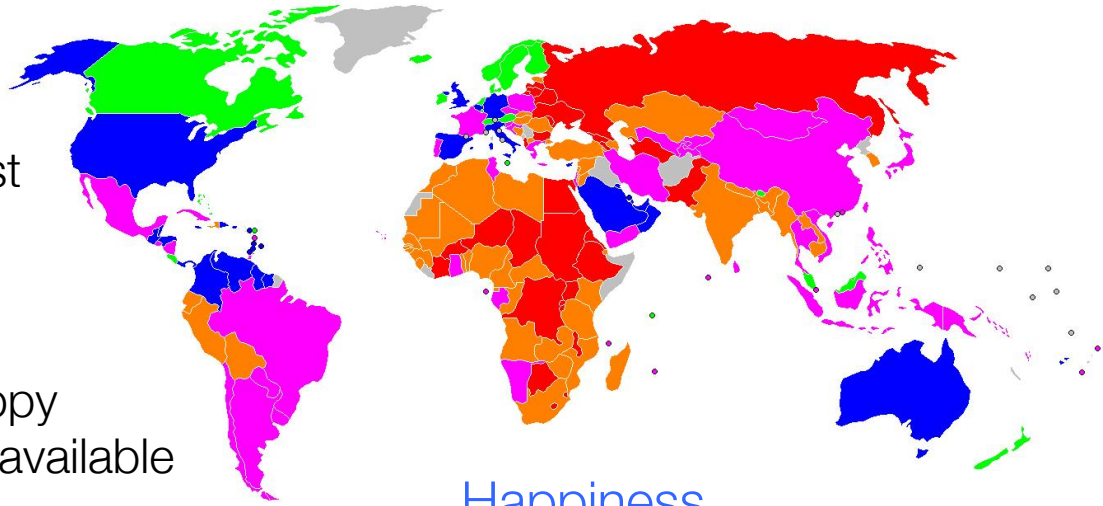


GDP

- Solidarity, cooperativeness,
- compliance,
- reputation, trust,
- attention, curiosity,
- happiness, health,
- environmental care…

Goal: Creating indices better than GDP

Green = Happiest
Blue
Purple
Orange
Red = Least Happy
Grey = Data not available



Happiness

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An Open, Transparent Platform for Everyone

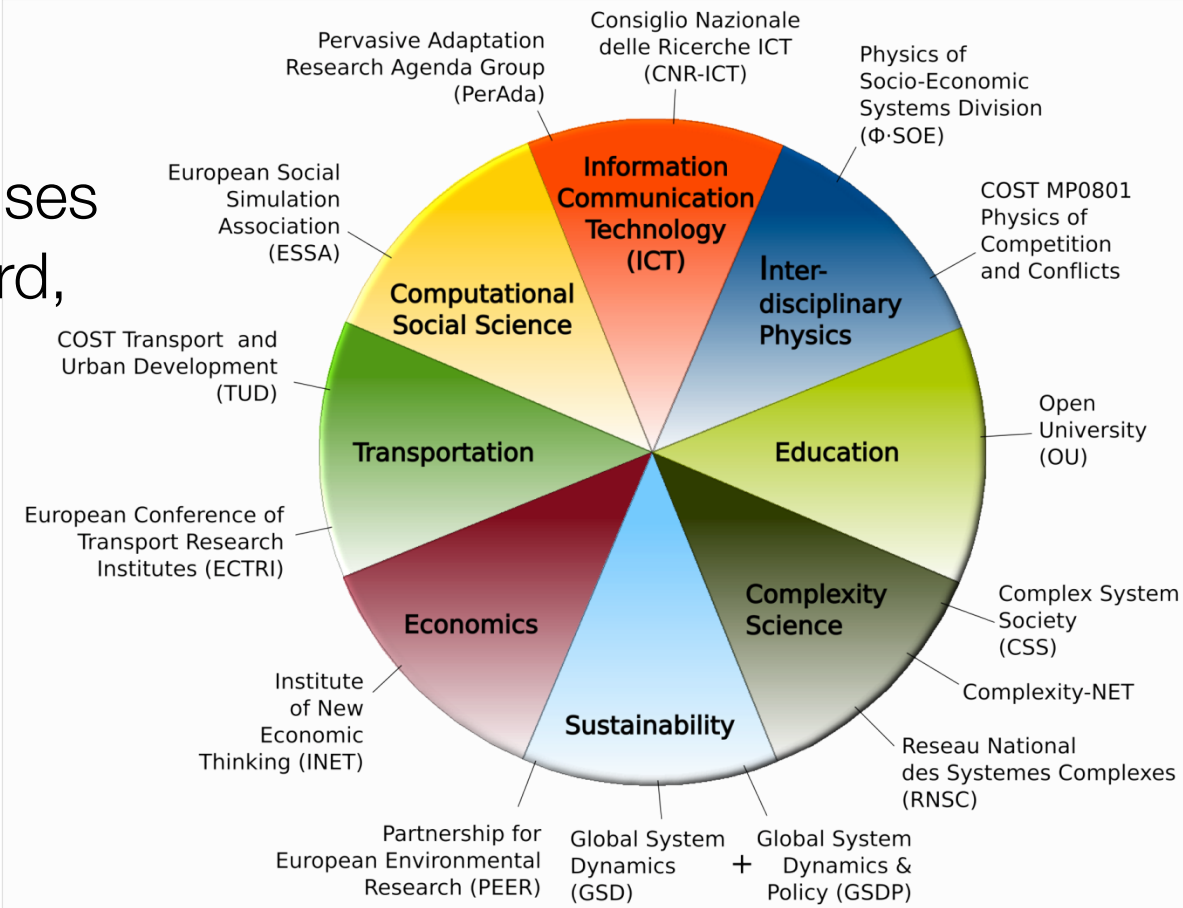
- Goal: Overcome “black holes” for data and data fragmentation
- An open platform for everyone
- Transparent data sources and quality, transparent algorithms, transparent results
- Transparent, responsible use
- A new public good, like our environment, air, and languages
- Potentials: New services and jobs, less barriers for social, economic and political participation, an age of creativity
- Problem: Mechanisms needed to avoid data pollution, manipulation, misuse, cybercrime

Towards A Trustable Web

- Require ownership and control of users over their data (see WEF document)
- Need privacy-respecting information systems, hence pseudo-/anonymity
- How to reach responsible use?
- Requires a decentralized, transparent, and manipulation-resistant reputation system for information contents and providers
- Principle: A self-organizing and self-regulating system, something like a socially adaptive and mutually beneficial information ecosystem
- For a suitable design principle, we need to understand social systems, otherwise instabilities, coordination problems, poor system performance, conflicts, (cyber) crime, and (cyber)wars will result

FuturICT: Community, Facts and Figures

- >700 supporters
- involves European science powerhouses (ETHZ, UCL, Oxford, Imperial, 5 supercomputing centers)
- Communities in all major European countries



The FuturICT Knowledge Accelerator integrates the best of all relevant knowledge

Possible National Focus Areas and Responsibilities

FuturICT's Benefits Scale with Societal Costs

1. Financial crisis: Losses of 2.2 trillion $
2. Conflict: Global military expenditures amount to 1.5 trillion $ annually.
3. Terrorism: 9/11 attacks caused 90 billion $ lost output of the US economy
4. Crime and corruption: 2-5% of GDP, about 2 trillion $ annually.
5. Flu: A true influenza pandemic infecting 1% of world population would cause losses of 1-2 trillion $ per annum
6. Congestion: 7-8 billion £ only in UK

- Even a 1% improvement would create benefits many times higher than project investments
- For comparison: Weather forecasts cost 10 CHF per citizen, but create a 5 times higher benefit.
- Business opportunities: Facebook's value, for example, amounts to 60-80 billion $

A Galiean Paradigm Shift in Our Thinking Is Needed

Our Previous World	Our New World
Separate or weakly connected system components, local or regional interactions	Strongly connected and interdependent system components, global interactions
Dominated by the (visible) system components	Dominated by their (invisible) interactions
Simple system behaviour	Complex system behaviour
Sum of properties of individual system components characterizes system behaviour	Emergent collective behaviour, implies new (and often unexpected) system behaviour
Conventional wisdom works well	Counter-intuitive behaviour, extreme events are common
Well predictable and controllable in top-down fashion	Less predictable, management by setting rules for bottom-up self-organization

Future challenges cannot be solved within our current paradigm!
This scientific paradigm shift has started – it is time to push it forward.